Analysis of Jupiter-illuminated images of Io: a new basis for understanding the purity of sulfur on its surface.

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The surface of 10 is believed to consist primarily of' elemental sulfur allotropes and sulfur dioxide (1.,2). However, the exact nature of these materials, their purity, their fractional surface coverage, and their interaction with a possible SO_2 atmosphere are still uncertain.

During the Voyager 2 encounter about 1.0 sequences of the dark (Jupiter-illuminated) side of Io were obtained. These images represent a unique opportunity for understanding several problems relating to the surface composition of Io. Since the difference in Ionian surface temperature between noon and early morning is 70 degrees near the equator (3), the laboratory behavior of various forms of sulfur and SO_2 in different. temperature environments can be compared with photometric measurements of the sun-illuminated and Jupiter-illuminated sides of 10.

One problem that has been addressed previously (4) is the question of condensation of SO_2 frost on the night side of 10. According to standard vapor pressure curves (3), the vapor pressure of SO_2 drops more than 10 orders of magnitude between day and night temperatures on 10. The existence or absence of SO_2 condensates on the night side is thus a sensitive indicator of an SO_2 atmosphere. Veverka et al. (5) failed to observe post--eclipse brightening as Io emerged from Jupiter's shadow. However, our preliminary analysis of images of Io obtained on the night side suggests localized brightening of -25% may exist.

Another problem that dark side images can address is the question of the purity of sulfur on Io's surface. Although no silicate features have yet been identified on Io, various lines of evidence suggest that it does exis' First, the bulk density of 10 (3.55 gm cm'^{1}) and the existence of significant topographic features suggest that. the bulk composition of Io is dominated by silicates. High temperature volcanic events (8) and photometric evidence (9) also point to significant amounts of silicates or other contaminants. Another piece of evidence is provided by the comparison of the spectra of day and night sides of Io with laboratory spectra obtained in different temperature environments. Gradie et al. (9) found that the 0.45 micron absorption band of "yellow" sulfur shifts at. an average rate of 1.6 Angstrom/degree between 80 and 300 Kelvins (the shift is closer to 1.0 Angstrom/degree near 80 Kelvins). They conclude that since there is an absence of spectral changes as the dayside solar incidence angle (and thus temperature) changes, pure sulfur does not exist on the surface of Io. Examination of the nightside images represents an even more sensitive indicator for pure sul fur.

We calculate that between 60 and 130 degrees (the minimum nighttime and maximum daytime temperatures, respectively), the relative spectral reflectance for "yellow" sulfur observed in the Voyager green and clear filters decreases by 25%. If pure sulfur exists on the surface of' lo, this decrease should be detectable on the nightside images.

A search of the Voyager 2 Jupiter-illuminated images yielded a single pair of green and clear images which are appropriate for this study (green is the only filter other than the clear filter for which observations were obtained on the night side). Maps of the clear to green filter ratios will be shown of the same regions under both Jovian and solar illumination.

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